7-1-2010

Longevity Risk Management in Singapore's National Pension System

Joelle HY Fong
The Wharton School, University of Pennsylvania, hfong@wharton.upenn.edu

Benedict SK Koh
Singapore Management University, skkoh@smu.edu.sg

Olivia S. Mitchell
The Wharton School, University of Pennsylvania, mitchelo@wharton.upenn.edu

Longevity Risk Management in Singapore's National Pension System

Abstract
Although annuities are a theoretically appealing way to manage longevity risk, in the real world relatively few consumers purchase them at retirement. To counteract the possibility of retirees outliving their assets, Singapore's Central Provident Fund, a national defined contribution pension scheme, has recently mandated annuitization of workers' retirement assets. More significantly, the government has entered the insurance market as a public-sector provider for such annuities. This paper evaluates the money's worth of life annuities and discusses the impact of the government mandate and its role as an annuity provider on the insurance market.

Keywords
Annuity, singapore, mortality, payouts, adverse selection, population, insurance, premium, retirees

Disciplines
Economics

Longevity Risk Management in Singapore's National Pension System

Joelle H.Y. Fong, Olivia S. Mitchell, and Benedict S. K. Koh

July 2010

PRC WP2010-10
Pension Research Council Working Paper
Pension Research Council
The Wharton School, University of Pennsylvania
3620 Locust Walk, 3000 SH-DH
Philadelphia, PA 19104-6302
Tel: 215.898.7620 Fax: 215.573.3418
Email: prc@wharton.upenn.edu
http://www.pensionresearchcouncil.org

Fong is a doctoral student and S.S. Huebner Foundation Fellow at the Wharton School, University of Pennsylvania; Mitchell is International Foundation of Employee Benefit Plans Professor of Insurance and Risk Management, and Executive Director of the Pension Research Council/Boettner Center at the Wharton School, University of Pennsylvania; and Koh is Professor of Finance at the Singapore Management University. The authors acknowledge helpful assistance and advice from Desmond Chew, Libby Sang, and Lee Ee Jia; we are especially grateful to Jean Lemaire for valuable insights. Opinions are solely those of the authors who acknowledge research support from the Wharton-SMU Research Center at Singapore Management University, and the National Institutes of Health (National Institute on Aging, Grant number P30 AG12836), the Boettner Center for Pensions and Retirement Security at the University of Pennsylvania, and National Institutes of Health (National Institute of Child Health and Development Population Research Infrastructure Program R24 HD-044964), all at the University of Pennsylvania

Longevity Risk Management in Singapore's National Pension System

Abstract

Although annuities are a theoretically appealing way to manage longevity risk, in the real world relatively few consumers purchase them at retirement. To counteract the possibility of retirees outliving their assets, Singapore's Central Provident Fund, a national defined contribution pension scheme, has recently mandated annuitization of workers' retirement assets. More significantly, the government has entered the insurance market as a public-sector provider for such annuities. This paper evaluates the money's worth of life annuities and discusses the impact of the government mandate and its role as an annuity provider on the insurance market.

Keywords: payout annuity, defined contribution, pension, retirement income, money's worth, adverse selection, public provision, crowd out

Joelle H.Y. Fong
PhD candidate, Department of Insurance and Risk Management
The Wharton School, 3620 Locust Walk, St 3000 SHDH
Philadelphia, PA 19104-6320
Email: hfong@wharton.upenn.edu

Benedict S. K. Koh
Professor of Finance, Singapore Management University
50 Stamford Road, #04-01
Singapore 178899
T: 65-6828-0716 • F: 65-6828-0777
Email: skkoh@smu.edu.sg

Olivia S. Mitchell
International Professor of Employee Benefit Plans
Professor of Insurance and Risk Management
Director, Pension Research Council
Boettner Center for Pensions & Retirement Research
The Wharton School, 3620 Locust Walk, St 3000 SHDH
Philadelphia, PA 19104-6320
T: 215-898-0424 • F: 215-898-0310
Email: mitchelo@wharton.upenn.edu

Longevity Risk Management in Singapore's National Pension System

Joelle H.Y. Fong, Olivia S. Mitchell, and Benedict S. K. Koh

While defined contribution (DC) pensions have enjoyed varying degrees of success during the accumulation phase, proponents of the DC model now confront the larger question of how participants will manage their capital throughout the payout phase so as not to run out of money in retirement. Not surprisingly, governments have become involved in this decision, as in the case of Switzerland where annuitization is the default payout modality; given a choice, most retirees elect to annuitize (Bütler and Teppa 2007). The U.K. has a long history of annuitization for those holding private DC pension accounts, yet retirees have substantial leeway over how much to annuitize and when (Finkelstein and Poterba 2002, 2004). And in Chile, workers have long been given a choice between phased withdrawal and annuitization when they claim their pensions (Mitchell and Ruiz 2010).

In contrast to such flexibility over annuitization, the Central Provident Fund (CPF) of Singapore has recently announced that retirement assets held by its citizens in the national defined contribution plan must be mandatorily annuitized so as to better protect retirees against the possibility of outliving their wealth. At the same time, the government has decided to enter the insurance market as a provider for these annuities. This paper evaluates the money's worth of privately-offered annuities prior to the reform, discusses the impact of the government mandate, and assesses how the entry of the government as an annuity provider is shaping the nation's insurance markets. Our results are of interest for several reasons. First, the CPF is widely acknowledged as one of the world's largest – and arguably most successful – defined contribution schemes. Accordingly it is valuable to see how this system is handling the

challenges of a rapidly aging population. Second, we seek to determine whether market failure – i.e. low value-for-money annuities – prompted the government to enter the insurance market as an annuity provider, and whether the new government-offered annuities will provide greater value to retirees.

We show that competitively-priced life annuities were offered by private insurers in Singapore prior to the reform, with money's worth ratios in the 0.88-1.05 range for males – on par with those in many other countries. Moreover, adverse selection costs were reasonable, on the order of 3.3 to 5.6 percentage points. The new government-offered annuities are estimated to provide money's worth ratios exceeding unity, benefitting annuitants on average but also implying that the annuity mandate will be expensive for the government if current pricing continues.

These findings are relevant to the current debate about how to best deploy annuities to manage longevity risk, within the context of a defined contribution scheme. On the positive side, mandating annuitization can reduce loads and adverse selection and can help retirees better manage the risk of outliving their income, as detailed by Emms and Haberman (2008) and Horneff et al. (2008). Yet on the negative side, mandating can also pose challenges. For instance, making annuity purchase compulsory produces utility losses for less risk-averse retirees.[1] Also, if left to private annuity providers, market distortions can arise: for instance, in the U.K. Murthi, Orszag and Orszag (2000) describe falling annuity yields, high markups on annuities, and 'mis-selling' incidents, which they attributed to a captive yet privately-run insurance market. By contrast, the Singaporean approach shows that a national government can both mandate and provide a risk-pooling scheme. Yet there are also risks in government provision, in that private insurers may be crowded out in the process. Indeed in Singapore, all but one of the eight private

[1] See for example, Mitchell et al (1999) and Blake, Cairns, and Dowd (2003).

insurers stopped selling CPF-compliant annuities between 2007 and 2009. Whether this crowd-out effect is short-term or permanent remains an open question and an important one to address in future research.

Background

Established in 1955, the Central Provident Fund is the mainstay of Singapore's old-age system. It is one of the world's largest defined contribution schemes with about 3.23 million members; the program also faces a rapidly aging population due to one of the world's lowest fertility rates (1.29 per female) and longest life expectancies (80.6 years at birth).[2] The government of Singapore has recently introduced the concept of a national longevity insurance scheme to address the challenges of increasing life expectancy given population aging (CPF 2009*a*). As of 2013, annuitization, rather than the current phased withdrawal approach, will become the mandatory vehicle for a portion of CPF retirement saving under the auspices of the regulatory public agency known as the CPF Board. Under the CPF LIFE scheme, new annuity products began to be offered in September of 2009.

Prior to this reform, the government had established the concept of a Minimum Sum (MS) which required participants at age 55 to set aside for retirement a specific dollar value of assets from their total CPF accumulations;[3] excess accumulations could be withdrawn as a lump-sum.[4]

[2] Figures for year-end 2007 from the Singapore Department of Statistics (SDOS 2008*a*).

[3] The required Minimum Sum is set by the CPF and increases each year. It was S$80,000 in 2003, S$99,600 in 2007 and it is expected to be about S$134,000 in 2013 (CPF 2008 and 2009*b*).

[4] If a member's total balance is higher than the Minimum Sum, any remaining balance can be withdrawn as a lump sum. If the total balance is less than the Minimum Sum, the following withdrawal rules currently apply to members who reach age 55 between 1/1/2010 and 6/30/2010: if the balance ≤ $5,000 one may withdraw everything; if $5,000 < total balance ≤ $16,667 one may withdraw $5,000 and set aside the remainder in the Retirement Account; and if $16,667 < total balance ≤ $167,143 one may withdraw 30% of the balance and set aside the remainder in the Retirement Account (CPF 2009*c*).

This Minimum Sum had to be preserved to age 65 (previously 62) before any drawdowns were permitted, and the default decumulation option after that was a phased withdrawal scheme paying benefits over about 20 years (or until the balance was exhausted). This framework exposed participants to significant longevity risk, since about half of all age-65 members would be expected to outlive their assets (CPF 2008). Those having the full Minimum Sum amount in cash could voluntarily buy a life annuity from private insurers, but this group was a small fraction of the total. Among the active members who turned 55 in 2008, only about one-third had accumulated the required MS (CPF 2009*b*). And only one in six eligible to do so actually elected to buy an annuity from private insurers under the MS Scheme,[5] perhaps because the phased withdrawal payout of S$790 was higher compared to an average monthly annuity payment of S$520.[6] Another reason might be costs; indeed Prime Minister Lee suggested as much in stating that "frankly speaking, the returns have not been very attractive, (and) the costs have been high." (SPMO 2007).

In 2007, the Singapore Government convened a National Longevity Insurance Committee (NLIC) to study the feasibility of the national longevity insurance scheme. After extensive hearings and review, it concluded:

> *The operation of the scheme will involve significant mortality and investment risks over a very long time horizon.…The committee notes the difficulties that some annuity providers abroad had run into when various risks were not properly managed. In some circumstances, provider risked insolvency as they were unable to meet liabilities... Members of the public have therefore expressed a preference of the CPF Board to administer the scheme due to the favorable CPF interest rates.…participants will need to have confidence in this national scheme to provide for their retirement, the operator must engender public trust and have strong administration capability" (CPF 2008).*

[5] See Fong et al. (2010).

[6] This applies to a member with the full Minimum Sum of $99,600 at age 55 (as of 2007) (CPF 2007). Under phased withdrawal, he could draw down his balance plus interest via monthly payouts of $790 and the flow would continue for 20 years at which point the balance is likely to be exhausted.

In other words, the Committee argued that the government should offer annuities due to greater public trust and perhaps greater efficiency, and indeed it is possible that a government-run pooling scheme could benefit from better annuity pricing through economies of scale and lower administrative loads. Furthermore, if it could become the primary provider, it could pool sufficient annuitants such that the average mortality risk of the pool would decrease. Mitigating these advantages include concern about whether the public sector would have sufficient in-house expertise and might crowd out commercial insurers. In any event, in February 2008, the government mandated life annuities and also required the CPF Board to operate a national longevity insurance scheme that would "give Singaporeans confidence that the scheme will be properly administered" (CPF 2008). Personnel from the Ministry of Manpower and the CPF Board devoted almost two years to design the system, consulting industry professionals in the process. The launch of the pilot program in September 2009 was accompanied by intensive public education through the media, road-shows, and pamphlets, and it generated substantial interest: since launch, over 30,000 members committed about S$1.5 billion to the CPF LIFE scheme (CPF 2010).

In what follows, we assess whether unattractive annuity yields and high costs were, in fact, problematic in the Singaporean context and thus might rationalize government provision.

Methodology: Modeling Money's Worth Ratios

A large literature focuses on measuring the money's worth of annuities in Western countries. Consistent with that opus, we define the money's worth ratio (MWR) of a payout annuity as the ratio of the expected present discounted value (EPDV) of annuity payments to the initial premium (Mitchell et al. 1999). Whereas a fairly priced annuity with no loadings will have

a MWR of unity, in the real world, privately-sold annuities have MWRs of less than one due to administrative costs and adverse selection. Adverse selection occurs in a voluntary market since those who elect to purchase a payout annuity tend to live longer than those who do not; adverse selection raises prices for all those who do purchase. Adverse selection costs are computed as the difference between the MWRs using annuitant versus population survival tables (Mitchell et al. 1999). Many prior studies have used the MWR notion to measure value for money in a range of annuity products including constant and rising payout products, joint-and-survivor annuities, and annuities with guarantee periods (cf. Mitchell et al. 1999; Brown et al. 2001; Finkelstein and Poterba 2002, 2004; Thorburn et al. 2005).

The annuities offered under the Singaporean CPF scheme are somewhat different from products on offer elsewhere, as they include a guaranteed amount if the death of the insured occurs in a specified time frame. Specifically, when the insured dies, the beneficiary receives the guaranteed amount of the single premium plus accrued interest (if any) less total amount of annuity payouts already made (if positive).[7] The refund, which is a lump-sum payment to the beneficiary, provides an element of capital protection.[8] Accordingly, the expected present discounted value (EPDV) of a nominal annuity with a guaranteed amount may be written as follows:

[7] Accrued interest is accumulated from age 55 when the premium is paid to the point where payouts start (at age 62 in 2007). Not all annuities incorporate the accrued interest component in the guaranteed amount on death. Accrued interest ranges from 0% to 2.5% per annum in 2007; see Table 1.

[8] This is somewhat similar to the money-back annuities available in other countries. For example, value-protected annuities that were introduced in the U.K. in 2006 feature partial money-back option where the lump-sum death benefits are permitted up to age 75, and are taxed (Boardman 2006).

In Equation (1a), is the age at which the annuity is purchased, represents the number of months beyond the annuity start date, refers to the fixed monthly nominal annuity payout for the individual purchasing the annuity at age , is the nominal discount rate at month t based on a riskless term structure, and is the probability that an individual of age survives after months. To account for the guarantee amount and the deferral period, we also define to be the deferred period (expressed in months), is the death benefit at time , and is the probability of an annuitant age *a* surviving to months and then dying between month and month . The first term in Equation (1a) captures the guarantee amount to the beneficiary if the insured dies during the deferral period, while the second term reflects benefits paid to the insured if he lives to the point when payouts start. Alternatively, the formula can be more neatly presented per Equation (1b) where the first summation accounts for the death benefit arising from the money-back guarantee, and the second summation captures the annuity benefit over the lifetime of the individual:

To implement the EPDV valuation for Singapore, we use the newly released population mortality tables from Singapore Statistics (SDOS 2008*b*) having a limiting age of 100; we then cohortize the population tables (as cohort mortality tables are unavailable) using period life tables. Thus having a year 2007 period life table, we compute:

where is the annual mortality rate for age *x* in year 2007, is the estimated annual mortality rate for age in year , and represents the estimated annual mortality improvements for an individual aged extrapolated from mortality changes

between 1990 and 2005. As in previous studies, mortality improvement rates are projected from the abridged period population tables for Singapore published by the World Health Organization (various years).

Little is publicly known on actual annuitant mortality experience in Singapore. Insurance industry practice and previous research including Fong (2002) has adopted the UK annuitant mortality experience with adjustments for local conditions, similar to what is done in Australia. The Monetary Authority of Singapore (MAS) in its capacity as insurance regulator requires firms to employ the UK a(1990) Ultimate Tables rated down five years for reserves and liability valuations pertaining to annuities sold (MAS 2008a).[9] Accordingly, we use the a(1990) tables with a five-year setback to estimate the annuitant experience for our valuation year, and then we cohortize the resulting annuitant tables.[10] We compute cumulative survival probabilities from the cohort tables as follows:

where is the cumulative probability of a person aged surviving for years, and is the probability of a person age dying within the year. These cumulative survival probabilities are sex-specific and calculated on a monthly basis to match the frequency of the annuity payouts. In addition, we apply a uniform distribution of deaths (UDD) assumption to reflect mortality patterns in Singapore. We justify using UDD for fractional ages within a year

[9] The Sixth Schedule of the Insurance Regulations 2004 stipulates that insurers may employ the rates in the UK a(90) tables with a five-year setback to value their annuity liabilities. Previously, Insurance Regulations 1992 required insurers to employ the a(1990) tables with a two-year setback. The a(1990) tables are constructed based on UK annuitants' mortality experience from 1967-70 with mortality improvements projected to 1990. By applying the 5-year setback, we effectively age the tables to Year 2007 and then cohortize for the MWRs.

[10] As a robustness check, we verify that our calculations yield a lower mortality for annuitant cohort than the population cohort; for instance, a 65-year-old male in the general population has a mortality of 0.01028 compared to 0.00933 for an annuitant.

due to the lack of variation in Singapore's weather (so death rates are unlikely to vary seasonally).[11] We match the limiting age of the population group with that of the annuitant group by extrapolating population mortality estimates to the common maximum age of 117 to properly capture the longevity tail risk in the population group.[12] This improves comparability between the two groups by ensuring that a person drawn randomly from the population also has some probability of survival leading to annuity payouts even at the tail end, rather than being curtailed at 100 years of age.

Figure 1 compares the cumulative survival probabilities we derive for the general Singaporean population and for annuitants. The Figure shows the probability that a 55-year old man (or woman) will survive to various ages given mortality rates for the population at large, as well as those for annuitants. Not surprisingly, the average 55-year old annuitant has a higher survival probability at all ages, implying some adverse selection costs to be discussed below.[13]

The EPDV calculation requires a term structure of interest rates; we judge the Singaporean Treasury bond rates as most appropriate since the MSS annuities are viewed as capital protected. Prices and yields of the Singapore Government Securities Treasury bonds obtained from MAS (2008*b*) are used to compute the riskless spot rates to proxy the yields on hypothetical zero coupon bonds.[14] To obtain the full term structure, we then linearly interpolate

[11] Various actuarial assumptions could be used for fractional ages within a year, including a uniform distribution of deaths, a constant force of mortality, or a hyperbolic pattern (Bowers et al. 1997). Prior studies on MWR have not explicitly specified assumptions for fractional ages within a year (e.g. Doyle et al. 2004). For a plot of our values of derived from the UDD assumption, see Appendix 1.

[12] We use population period tables from Singapore Statistics. These tables had applied the Coale-Kisker method to project mortality at higher ages, using a separation factor of 0.5 (SDOS 2008*b*). Given q_x for ages 85 -99, we back out the death rates (m_x) and observe that the change in m_x between each age interval is constant at about 9.3%. Extrapolating this constant graduation rate, we then derive the q_x for ages 100 -117.

[13] Finkelstein and Poterba (2002) attributed these mortality differences largely to socio-economic, or passive, selection effects.

[14] The first year rate is derived from the 1-year Treasury bill; thereafter, the 2, 5, 7, 10, 15 and 20-year Treasury bond rates as of 2007 are used to estimate the riskless spot rates. Our annual spot rate ranges from 1.4% to 3.44%. Since maximum duration available is only 20 years, we then extrapolate the last spot rate into the future, yielding a nominal riskless term structure of interest rates on Singapore's Treasury bonds.

between intervals where spot rates are unavailable, for instance between the 7- and 10-year spot rates.[15]

Figure 1 here

Results: MWRs for Voluntary Private Annuities

Prior to the mandatory annuity reform, plan participants with sufficient cash could voluntarily purchase a life annuity from 7-9 insurers participating in the market; the firms included some international players with Singaporean offices (e.g. AIA, Prudential, and HSBC Insurance), as well as several local insurers.[16] This program promoted annuity purchase among CPF participants; Fong (2002) estimated that as at 2000, about 87 percent of all Singapore annuitants had purchased their policies through this scheme. The annuity premium equaled the prevailing Minimum Sum for the year, and insurers were free to determine participant payouts and guarantee amounts. In 2007, for instance, in exchange for a lump-sum premium at age 55 of S$99,600, monthly annuity payouts beginning at age 62 varied as outlined in Table 1. The nine annuities on offer by eight commercial insurers were similar in that the standard deviation in payments was only about five percent. All annuities had fixed nominal payouts; two also promised a non-guaranteed annual bonus payment depending on the insurer's performance. Level monthly payouts ranged from S$495-559 for males and S$441-514 for females; the guaranteed amount upon death was at least the premium S$99,600 and several annuities paid interest of 0.5-2.5%.

[15] See Appendix 2 for a list of key inputs compared to those used in two earlier money's worth studies for annuities in Singapore.

[16] As at Dec 2007, three insurers accounted for almost 80% of the total market share for individual annuity policies, inclusive of annuity purchases using non-CPF pension saving (MAS 2007). In particular, a home-grown co-operative, NTUC Income, has long been the market leader with 58% market share and about 38,000 annuity policies in force as at end 2007. Great Eastern Life and UOB Life have approximately 11% market share each, higher than that of AIA (8.5%) and Prudential (1.6%).

Table 1 here

Using these annuity quotes in Equation (1) generates the desired MWRs reported in Table 2. Here we see that, per premium dollar, the typical male annuitant would have anticipated receiving an average of $0.947 and the female $0.955 in 2007. It is also of interest that the NTUC Income co-operative offered the highest money's worth ratios of 1.047(males) and 1.081 (females); these exceeded the private insurer average by 10.5 and 13.1 percent, respectively.[17] We measure the cost of adverse selection as the difference in the MWR using population versus annuitant tables. Our values of 3.3–4.1 percentage points (or cents per $1 premium) for males and 4.2–5.6 for females are comparable to the U.K. figure of 4.6 reported by Finkelstein and Poterba (2002) but below the 6 and 10 percentage points found for Australia and U.S. respectively (Doyle et al. 2004; Mitchell at al. 1999). In terms of proportion, we see from the Table that adverse selection costs accounted for about 47% of the total loadings, which is quite reasonable compared to other countries. For example, in the U.S., Brown et al. (2001) found that roughly half of the cost of purchasing a voluntary annuity could be attributed to adverse selection.

The reasonable adverse selection costs observed in the private annuity market in Singapore may be partly attributed to the unique characteristics of the MS Scheme annuities. For one thing, the premium guarantees contribute significantly to reducing adverse selection; indeed in results not reported here in detail, removing the embedded guarantee would increase adverse selection by 20-26 percent. Also important is the deferral period on these annuities (between ages 55 and the benefit-claiming age). Without this, adverse selection would have been higher by 9-13 percent. In any case, the annuity marketplace prior to the most recent reform offered

[17] NTUC Income is a non-profit oriented co-operative for the Workers' Union. This result is consistent with NTUC Income's mission to return the majority of profits to policyholders (NTUC Income 2009).

relatively competitively priced products, by world standards, with reasonable adverse selection costs.

Table 2 here

Sensitivity Analysis

As noted earlier, annuitant mortality rates for Singapore are derived from UK annuitant tables, due to lack of annuitant experience in Singapore. To evaluate how sensitive our results are to variations in mortality, we modify the tables to allow life expectancy to vary by two years on either side of our base case estimates, dated from the year of purchase. The mortality of a 57-year-old then represents a +2-year adjustment and the mortality of a 53-year-old represents a –2-year adjustment. Results in Table 3 (Panel A) show that lightening mortality by two years exacerbates adverse selection, while the opposite holds when mortality is made heavier. In addition, the adjustments make slightly more difference to the adverse selection results for males than females. We also explore sensitivity to interest rate variations. The Singapore government bonds were used to derive the riskless term structure. The spot rate on the 20-year bond (3.44%) was used as a proxy for the long-term interest rate for periods beyond 20 years. Sensitivity testing using 50 and 100 basis points around the central case shows that money's worth values are sensitive to these changes, as Table 3 (Panel B) indicates. In any event, our estimates of adverse selection remain robust.

Table 3 here

Results: MWRs for Mandatory Annuities

Under the new CPF LIFE scheme introduced in 2009, participants may either purchase a private annuity or select from a menu of government-offered annuity products called the CPF LIFE plans. Initially the intention was to provide a dozen different payout options outlined in 2008, but the menu was later pared back to four plans in 2009 after public feedback suggested that too much choice was confusing. The final four are known as CPF LIFE Basic, LIFE Balanced, LIFE Plus, and LIFE Income. Table 4 presents illustrative payouts for the various LIFE plans as the government's proposals evolved, for an annuity premium of half the estimated Minimum Sum or S$67,000 in 2013.[18] For that premium, benefit payouts were initially set to be quite generous: in six of the 12 original plans proposed in early 2008, monthly payouts would have ranged from S$560-650 for males and S$540-590 for females. By September of 2009, when the final LIFE plans were launched, promised monthly payouts had been adjusted downward to about S$524-636 for men and S$500-553 for women.

Table 4 here

Table 4 also shows the 'annuity component' expressed as a percentage of the annuity premium. That is, the CPF LIFE products split the premium paid into a term and an annuity component. The first covers payouts from age 65 to the vesting age which differs across the plans; any unused balance from the term component and interest from it is fully refundable to one's heirs. The annuity component finances payouts from the vesting age to death with no funds passed on to the beneficiary. Thus the four finalized LIFE plans provide a range of trade-offs, balancing providing for oneself and leaving a bequest for one's beneficiaries. In practice, the transition from the term to the annuity component is purely procedural and does not affect

[18] By 2013, the prevailing Minimum Sum is expected to be about S$134,000 (S$99,600 in 2007). The CPF estimated that of the approximately 35,000 active members in the 2103 cohort of members turning age 55, about 60% will have at least S$67,000 in cash in their Retirement Accounts (CPF 2008).

monthly benefits to any CPF member in receipt, with the interest from the annuity component being non-refundable to individual participants as it funds the CPF LIFE scheme. In other words, interest forfeited represents participants' opportunity cost of joining the LIFE plan. This cost is factored into the money's worth computations by means of a guaranteed amount G_t that falls as the retiree ages. While the LIFE Plus and LIFE Income plans both have an annuity component, the LIFE Plus product permits some bequest whereas LIFE Income allows none.[19] A retiree who opts for the LIFE Income product received a higher monthly payout while alive, making the product most appealing to unmarried or childless individuals. By comparison, the LIFE Basic plan provides for the highest bequest amount in exchange for the lowest monthly payouts by allocating most to the term component. The LIFE Balanced plan provides an intermediate mix.

Since these annuities are being mandated, we generate money's worth values using Singapore population mortality tables. Results in Table 3 show that the government LIFE plans offer excellent value-for-money to annuitants. [20] For instance, using the riskless term structure with a long-term rate assumption of 3.44 percent, MWRs range from 1.24-1.31 for males and 1.26-1.34 for females. These values are far above those provided by the privately-provided life annuities where it will be recalled that mean MWRs were 0.947 for men and 0.955 for women (using annuitant mortality). It might be thought that the interest rate environment in Singapore is

[19] The bequest on the LIFE Plus plan is the unused portions of the annuity component (which in this case is equal to the premium paid). In other words, the refund is the premium paid less annuity payouts already made. Members who join CPF LIFE may not withdraw unless they have medical grounds of shortened life expectancy, or if they are leaving Singapore and West Malaysia permanently with no intention of returning to either country. Members are also not allowed to change their LIFE plans after joining the scheme (CPF 2009*d*).

[20] Based on communications with the CPF Board, we also assume interest rates are compounded and credited annually to the Retirement Account (RA), but if the member dies in any month, any interest earned up to that point in time is immediately credited and so refunded. Even when a member reached vesting age, any unused balance in the RA continues to earn interest. If the member adds top-ups to the RA, this also forms part of the principal and earns interest. On death, any unused balance in the RA is refunded. For the original 12 plans, the extra 1% earned on the total MS is allocated pro-rata to the RA and pooled interest based on the component balances for each month. However, for the final four plans, the extra 1% earned on the total MS is allocated entirely to the RA. Finally, if the member dies after vesting age, any unused balance of the annuity component (except for the LIFE Income plan), will be refunded to his beneficiaries.

unusually low, so we recomputed the MWRs using a higher long-term rate of 4.44 percent (close to the yield of the longest-term 10-year bond in 1998); under these circumstances, the MWRs appear in brackets in the last four rows of Table 3. The higher interest rate assumption still yields MWRs of 1.10-1.15 for males and 1.09-1.14 for females.

Looking at the patterns of benefit values, it is interesting to note that the LIFE Income (sans bequest) and LIFE Plus (low bequest) plans provide higher MWRs than do the other two plans, implying a small penalty if participants elect a plan that includes bequests. Also it is apparent that as the design was fine-tuned over time, MWRs were dialed down; perhaps policymakers realized that the early pricing was overly generous. Yet even so, MWRs of the CPF LIFE payouts remain at or slightly above unity, compared to the lower values of private insurer annuities that had been available. The government's higher payout results in part from lower administrative loads compared to those levied by private insurers, and in part from less adverse selection due to the compulsory annuitization (though above we had indicated this was relatively small in Singapore).[21] A long-term rate assumption set closer to historical norms also generates MWR values closer to one.

As the administrator, the CPF Board determines the premium and payouts with advice from independent actuarial consultants, so the new design may intentionally include a small subsidy to CPF members so as to jump-start the new scheme. Indeed the government has offered a sign-on bonus (called the L-bonus) for the first five cohorts of members joining CPF LIFE for whom the scheme is voluntary.[22] Also our computations assume constant nominal payouts

[21] Similarly, in the U.S. context, Abel (1986) showed that because the U.S. Social Security system is compulsory, it is immune to adverse selection and a fully funded system can offer a rate of return equal to the actuarially fair rate based on population average mortality.

[22] The L-Bonus is targeted at lower and middle-income CPF members age 46-50 in 2008. It is given to these members when they enroll in the CPF LIFE scheme at age 55. In fact, the LIFE Plus plan, which provides a higher monthly payout and leaves less bequest for beneficiaries has proven most popular in the pilot launch (CPF 2010);

though in fact, payouts may vary in the future, depending on the future evolution of interest rates and mortality. Though the CPF Board can adjust payouts periodically to reflect actual mortality experience and investment return, it is noteworthy that it has assured members that adjustments will usually be small so that nominal payouts are anticipated to remain relatively stable over time (CPF 2009*d*).[23]

Discussion and Conclusion

A topic of substantial interest to international policymakers is whether a national annuitization scheme should be administered by the private or the public sector.[24] Having a single provider can reduce costs through economies of scale, and a government-run scheme may be perceived to be safer by retirees than private insurers which may face bankruptcy (Babbel and Merrill 2007). In the Singaporean case, the Civil Service is regarded as one of the most efficient bureaucracies in the world with a high standard of discipline and accountability (Heritage.org, 2010) and the fact that the CPF has traditionally paid interest on annuities at a rate pegged to the 10-year SGS bond plus 1 percent with a 2.5 percent floor implies that citizens tend to view such returns as risk-free (given the AAA rating of government bonds). It is therefore interesting that the annuities offered by Singapore's CPF LIFE scheme appear to be priced very favorably to the consumer compared to other developed countries (see Table 5). Our preliminary evidence

---

over half of the members selected it. In addition, more than S$60 million of LIFE Bonus (L-Bonus) has been given to about 70% of the members for joining the scheme.

[23] Responding to members seeking to join CPF LIFE ahead of the official launch date of 2013, the CPF Board began offering LIFE plans in September of 2009 to members born in 1954 or before. Inasmuch as annuitization is not yet mandatory, this first phase of CPF LIFE operates on a voluntary opt-in basis (from 2013, annuitization will be mandatory). Younger members will be auto-included in the LIFE Balanced plan if they have at least $40,000 cash savings in their Retirement Account as of age 55. Members with less than S$40,000 can opt-in if they wish (CPF 2009*d*). The cut-off for auto-inclusion into CPF LIFE was selected to balance the level of monthly income and the percentage of active CPF members automatically included. At S$40,000, it is estimated that some 70% of active members will be automatically included from the first cohort (i.e. those who turn age 55 in 2013; CPF 2009*f*).

[24] Here we do not take up the question of whether mandatory annuitization is welfare-enhancing, a topic explored in some detail by Brown (2003).

therefore could indicate that Singapore has been able to pass cost savings from scale economies and onto annuitants.

Table 5 here

It is also worth noting that, while CPF members may still buy life annuities from a private insurer, few firms appear to be able to compete. That is, there were nine private insurance companies offering annuities in 2007, but only one remained by late 2009. The withdrawal of insurers from the annuity market may be of concern to policymakers if product innovation and pricing pressure requires competition among product providers in the industry. In addition, by marketing both life insurance and life annuities, insurers would be expected to benefit from some natural hedging across the two products. It is possible that private annuity providers could refocus their business outside the CPF scheme for retirees seeking to annuitize non-pension wealth. Also since the amount that CPF members can annuitize via the CPF LIFE product is capped at the stipulated Minimum Sum amount, wealthy individuals could still turn to commercial annuities. Moreover, the life annuities currently offered by the government are nominal and not inflation-adjusted and hence retirees may find some benefit from inflation-linked payouts, not currently available under the CPF LIFE system.

These findings are also of interest in nations where governments are increasingly concerned about annuitization in defined contribution plans. For instance, in the U.S. 401(k) pension marketplace, few retirees convert their assets into insured payout products and instead take their money as a lump sum (Brown et al. 2001). In response, to protect against longevity risk, some have proposed making annuitization the default payout mechanism from a defined contribution pension. For instance, Gale et al. (2008) recommend that 401(k) assets be automatically directed into a “trial” payout product unless the retiree affirmatively elects not to

participate. After 24 monthly payments from the automatic payout plan, the retiree could either do nothing and be defaulted into a permanent income distribution plan, or elect an alternative distribution option. By making it easier for retirees to purchase lifetime income plans, it is anticipated that these would become a better value for the average consumer.

We conclude that Singapore's recent move to mandate annuities under the national defined contribution pension system represents a logical step toward national longevity risk management. By establishing the government as an annuity provider, the CPF Board may have taken advantage of scale economies and reduced the pricing impact of adverse selection, given that the latter was found to be quite a substantial proportion of total loadings. Furthermore, the aggressive annuity pricing is creating public buy-in for the new mandate, while indirectly working to compensate less risk-averse individuals in terms of foregone equity premium. One offset may be that private insurers have been crowded out, in part because the CPF-designed product pays participants more than what commercial insurance companies had offered. Without competition, it is unclear whether annuity pricing will continue to be attractive and whether product innovation will continue in Singapore. Related questions, as yet unsettled, have to do with whether favoring annuity payments over payments to survivors is politically sustainable, and how long the government will be able to continue subsidizing payouts.

References

Abel, A.B., 1986, Capital Accumulation and Uncertain Lifetimes with Adverse Selection, *Econometrica*, 54: 1079 - 1098.

Avanzi, B., and S. Purcal, 2009, Forced Savings and Annuitization with Cross-Subsidies: A Mutation of the Beast. Working Paper, University of New South Wales, http://ssrn.com/abstract=1466386.

Babbel, D., and C. Merrill, 2007, Rational Decumulation,' Working Paper, Wharton Financial Institutions, http://ssrn.com/abstract=917223.

Blake, D., A. J. Cairns, and K. Dowd, 2003, Pensionmetrics 2: Stochastic Pension Plan Design during the Distribution Phase, *Insurance Mathematics and Economics*, 33: 29–47.

Boardman, T., 2006, Annuitization Lessons from the UK: Money-Back Annuities and Other Developments, *Journal of Risk and Insurance*, 73: 633-646.

Bowers, N., H. Gerber, J. Hickman, D. Jones, and C. Nesbitt, 1997, *Actuarial Mathematics* (Itasca: Society of Actuaries).

Brown, J., 2003, Redistribution and Insurance: Mandatory Annuitization with Mortality Heterogeneity, *Journal of Risk and Insurance*, 70: 17-41.

Brown, J., O. S. Mitchell, J. Poterba, and M. Warshawsky, 2001, *The Role of Annuity Markets in Financing Retirement* (Cambridge, MA: MIT Press).

Bütler, M., and F. Teppa, 2007, The Choice between an Annuity and a Lump Sum: Results from Swiss Pension Funds,' *Journal of Public Economics*, 91: 1944-1966.

Central Provident Fund Board (CPF), 2007, *CPF Minimum Sum Scheme: Table of Monthly Payment Rates for the Minimum Sum Of $99,600 placed with a Participating Insurance Company*, mycpf.cpf.gov.sg/NR/rdonlyres/883DD6D3-D1EC-48DD-8B09-811C 0D24ECE8 /0/AnnuityComparison.pdf, viewed 3/20/08.

CPF, 2008, *Report by the National Longevity Insurance Committee (NLIC)*, mycpf.cpf.gov.sg/ Members/Gen-Info/CPF_LIFE/NLIC.htm, viewed 12/31/09.

CPF, 2009*a*, *CPF Trends: Changing Age Structure of CPF Members*, Central Provident Fund Board, mycpf.cpf.gov.sg/NR/rdonlyres/BE898A08-642E-4EA1-9B6B-10C46AEA31EB/0/ CPFTrends_ChangingAgeStruct.pdf, viewed 12/31/09.

CPF, 2009*b*, *CPF Trends: Minimum Sum Scheme*, Central Provident Fund Board, mycpf.cpf.gov.sg/NR/rdonlyres/1CD89DEC-1CD2-4772-83CE-F6D2B65F3467/0/ CPFTrendsMinimumSum_2008.pdf, viewed 12/31/09.

CPF, 2009*c*, *CPF Withdrawal Calculator*, cpf.gov.sg/cpf_trans/ssl/financial_model/wdl_ assumption.asp, viewed 12/31/09.

CPF, 2009*d*, *CPF LIFE Information Booklets*, Central Provident Fund Board, September. mycpf.cpf.gov.sg/Members/Gen-Info/CPF_LIFE/CPF_LIFE.htm, viewed 11/15/09.

CPF, 2009*e*, *CPF LIFE Payout Estimator*, Central Provident Fund Board. cpf.gov.sg/cpf_trans/ssl/financial_model/lifecal/index.html, viewed 6/15/09 and 9/19/2009.

CPF, 2009*f*, *Frequently Asked Questions on CPF LIFE*, Central Provident Fund Board, mycpf.cpf.gov.sg/Members/Gen-Info/CPF_LIFE/CPF_LIFE.htm, viewed 12/31/09.

CPF, 2010, *CPF LIFE*, Central Provident Fund Board, mycpf.cpf.gov.sg/Members/Gen-Info/CPF_LIFE, viewed 5/11/10.

Doyle, S., O. S. Mitchell, and J. Piggott, 2004, Annuity Values in Defined Contribution Retirement Systems: Australia and Singapore Compared, *Australian Economic Review*, 37: 402-416.

Emms, P. and S. Haberman, 2008, Income Drawdown Schemes for a Defined-Contribution Pension Plan, *Journal of Risk and Insurance*, 75: 739-761.

Finkelstein, A., and J. Poterba, 2002, Selection Effects in the United Kingdom Individual Annuities Market, *Economic Journal*, 112: 28-50.

Finkelstein, A., and J. Poterba, 2004, Adverse Selection in Insurance Markets: Policyholder Evidence from the U.K. Annuity Market, *Journal of Political Economy*, 112: 183-208.

Fong, J. HY., O. S. Mitchell, and B. SK. Koh, 2010, Longevity Risk and Annuities in Singapore, in: R. Clark and O. S. Mitchell, eds., *Reorienting Retirement Risk Management* (Oxford University Press), *Forthcoming*.

Fong, W. M., 2002, On the Cost of Adverse Selection in Individual Annuity Markets: Evidence from Singapore, *Journal of Risk and Insurance*, 69: 193-207.

Gale, W. G., J. M. Iwry, D. C. John, and L. Walker, 2008, Increasing Annuitization in 401(k) Plans with Automatic Trial Income, Working Paper, Brookings Institution, Washington D. C.

Heritage.org, 2010, *Singapore: Economic Freedom Score*, www.heritage.org/index/pdf/2010/countries/singapore.pdf, viewed 5/31/10.

Horneff, W. J., R. H. Maurer, and M. Z. Stamos, 2008, Optimal Gradual Annuitization: Quantifying the Costs of Switching to Annuities. *Journal of Risk and Insurance*, 75: 1019-1038.

Mitchell, O. S., J. Poterba, M. Warshawsky, and J. Brown, 1999, New Evidence on the Money's Worth of Individual Annuities, *American Economic Review*, 89: 1299-1318.

Mitchell, O. S. and J. Ruiz, 2010, Pension Payments in Chile: Past, Present, and Future Prospects, in: O. S. Mitchell, J. Piggott, and N. Takayama, eds., *Revisiting Retirement Payouts: Market Developments and Policy Issues* (Oxford University Press), *Forthcoming.*

Monetary Authority of Singapore (MAS), 2008*a*, *Insurance (Valuation and Capital) Regulations 2004*, mas.gov.sg/resource/legislation_guidelines/insurance/sublegislation/Insurance%20(Valuation%20and%20Capital)%20Regs%202004.pdf, viewed 12/31/09.

MAS, 2008*b*, *Statistics Room: Daily SGS prices*, mas.gov.sg/data_room/index.html, viewed 12/31/09.

MAS, 2007, *Insurance Statistics: Individual Life Insurance: New Policies Issued Of Singapore Insurance Funds during the year ended, and Individual Life Insurance: Policies In Force of Singapore Insurance Funds as at 31 Dec 2007*. mas.gov.sg/data_room/insurance_stat/2007/Insurance_Statistics_2007.html, viewed 12/31/09.

Murthi, M., J. M. Orszag, and P. R. Orszag, 2000, Annuity Margins in the UK, OECD paper, oecd.org/dataoecd/30/61/2402277.pdf.

NTUC Income, 2009, *Annuity Plans*. income.com.sg/insurance/annuity, viewed 3/16/09.

Singapore Department of Statistics (SDOS), 2008*a*, *Statistics: Demography (Themes)*, singstat.gov.sg/stats/themes/people/demo.html, viewed 3/16/09.

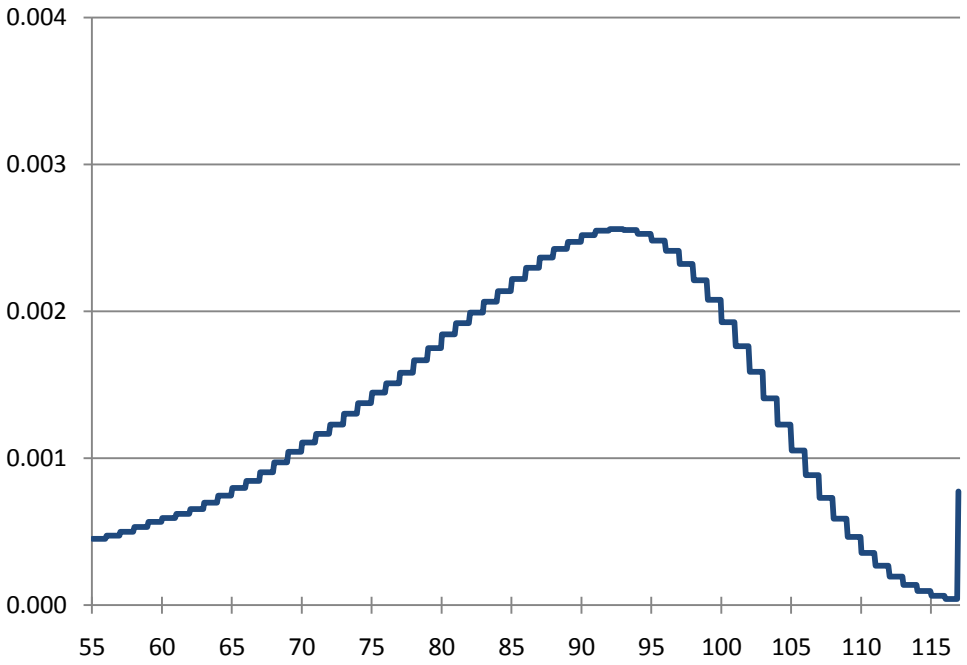
SDOS, 2008*b*, *Complete Life Tables for 2006 – 2007 for the Singapore Resident Population,* Information Paper, May.

Singapore Prime Minister's Office (SPMO), 2007, *Transcript of Prime Minister Lee Hsien Loong's National Day Rally English Speech*: *City of Possibilities; Home for All*, August.

Thorburn, C., R. Rocha, and M. Morales, 2005, An Analysis of Money's Worth Ratios in Chile, *Journal of Pension Economics and Finance*, 6: 287-312.

Appendix 1: Plot of (probability of dying between month and month conditional on having survived to month)

The figure plots for a random male drawn from the population who purchases an annuity at age 55 in 2007. It shows the probability of dying between month and month (conditional on living to month) increasing from age 55 to about age 95 where the rise in outweighs the decline in . In the advanced ages, the opposite occurs and the probabilities fall. The jags in the plot indicate that within each year, the probabilities are level consistent with the UDD assumption.



Appendix 2: Assumptions used in Money's Worth Computations for Life Annuities under the CPF MS Scheme

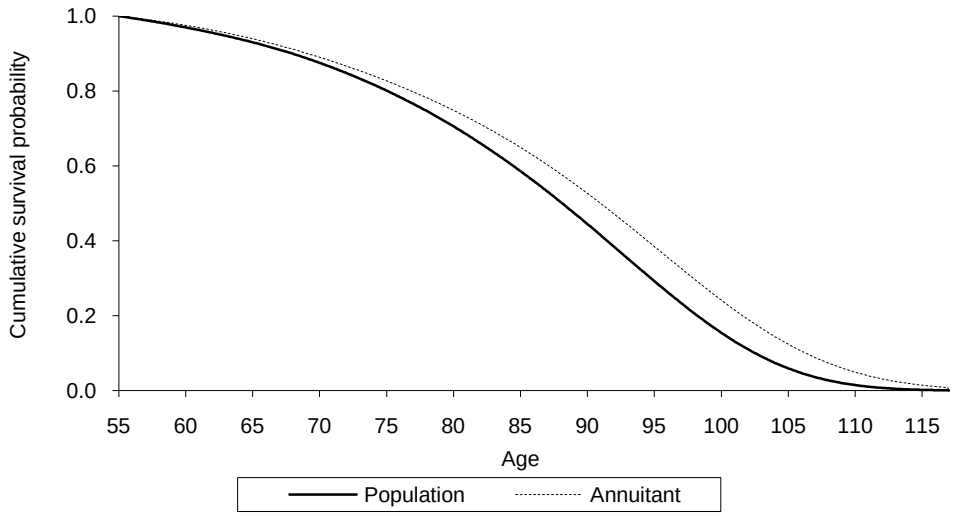
Study	Valuation Date; Sample chosen / Model	Mortality Assumption		Interest Rate Assumption	MWR for 55-year-old Male		Adverse selection (in pp)
		Annuitant	Population		Ann.	Pop.	
Fong (2002)	2000; subset of 8 non-participating annuities & 1 participating annuity. MWR model with 15-year certain.	a(90) with 2-year setback. Limiting age used is 109.	Derived from 1960 and 1990 Ordinary Male and Female Lives Tables (Singstat). Limiting age of 99.	Flat interest rate (proxy by the 10-year Government bond yield of 4.6%).	0.997	0.986	1.1
Doyle et al. (2004)	2000; subset of 5 non-participating annuities with a 15-yr guarantee period or similar. MWR model with 15-year certain.	a(90) with 2-year setback. Limiting age used is 109.	Abridged life tables for Singapore (World Health Organization). Limiting age of 100.	Term structure (yield curve with long-term rate assumption of 4.76%).	0.947	0.945	0.26
This study	2007; all MSS annuities: 7 non-participating & 2 participating annuities. MWR model for annuities with guaranteed amount; see Equation (1) in text.	a(90) with 5-year setback. Limiting age used is 117.	Complete life tables for Singapore resident population 2007 (Singstat), plus extrapolate from age 100 to 117. Limiting age of 117.	Term structure (yield curve with long-term rate assumption of 3.44%).	0.947	0.910	3.69

Source: Authors' computations; see text.

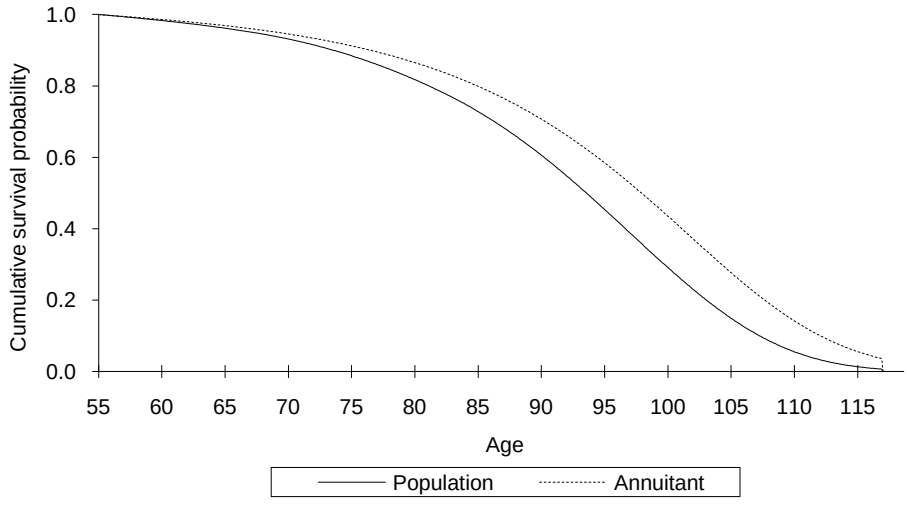
Notes: A total of 13 MSS life annuities were offered in July 2000 of which 9 were flat-rate annuities, 2 were participating annuities, and 2 were increasing annuities. The increasing annuities offered by AIA were dropped after that year (*Source*: Personal communication from CPF Board). The a(90) table refers to the UK a(1990) period life table for annuitants. It is based on UK annuitants' experience from 1967-70, with mortality improvements projected to 1990. Because of lack of annuitant experience in Singapore, previous studies used the a(90) and with a two-year setback to account for lower mortality among annuitants. A two-year setback means that a 65-year-old is treated as having the same mortality rate as a 63-year-old has in the initial table. Money's worth ratios are in decimals and adverse selection costs are in percentage points.

Figure 1
Cumulative Cohort Survival Probability: General Population and Annuitant groups (conditional on attaining age 55 and limiting age of 117; 2007)

A. Singaporean Males



B. Singaporean Females



Source: Authors' computations; see text.

Table 1
Monthly Nominal Payouts for Life Annuities purchased at the Minimum Sum of S$99,600 (2007; S$ per month)

	Monthly Annuity payout for entry age of 55		
Company & Product	**Male (S$)**	**Female (S$)**	**Guaranteed amount upon death (less total annuity payments)**
Non-participating Annuities			
Asia Life Assurance	505.47	454.47	Premium.
American International Assurance (AIA)	530.87	513.94	Premium.
Aviva	559.00	507.00	Premium + accrued interest compounded at 1% p.a. to commencement date of annuity.
Great Eastern Life (GE Life I)	535.35	484.30	Premium + interest accumulated at 0.75% p.a. to age 62.
Great Eastern Life (GE Life II) *[Note: This product includes long term care benefit.]*	494.26	440.73	Premium + interest accumulated at 0.5% p.a. to age 62.
Overseas Assurance Corporation (OAC)	535.35	494.26	Premium + interest accumulated at 0.75% p.a. to age 62.
Prudential Assurance	518.44	449.87	Premium.
Sub-average	***525.53***	***477.80***	
Participating Annuities			
HSBC Insurance	474.00 (541.58)	458.00 (525.58)	Premium + interest accumulated at 2% p.a. to age 62.
NTUC Income Co-op	523.50 (591.08)	490.25 (557.83)	Premium + interest accumulated at 2.5% p.a. and bonuses to age 62.
Sub-average	***498.75***	***474.13***	
Overall Average	**519.58**	**476.98**	

Source: Authors' computations from CPF (2007).
Notes: p.a. denotes per annum. Monthly payouts for a nominal deferred annuity purchased at age 55 with payments starting at age 62. The single premium is the Minimum Sum of S$99,600 for members age 55 (7/07-6/08). The MS Scheme currently guarantees named beneficiaries a given amount in the event of annuitant's death equal to the (positive) difference between the guaranteed amount and annuity payments made. Previously (in 2000) most MS annuities were guaranteed for a certain period so if death occurred during the guaranteed period, remaining annuity payments would be converted into a lump sum paid to beneficiaries. Bonus rates depend on company performance; NTUC Income's annual bonus rates were 1-3.5% historically (NTUC 2009) and a 2% bonus is used in NTUC Income benefit illustrations. Original payouts without bonus expressed without brackets; figures in brackets incorporate bonus component assuming an annual projected bonus rate of 2%.

Table 2
Money's Worth Ratios and Adverse Selection Costs for Nominal Life Annuities Offered by Private Insurers under the CPF Plan (2007)

Company & Product	Male			Female		
	Population MWR	Annuitant MWR	Adverse Selection	Population MWR	Annuitant MWR	Adverse Selection
Non-participating Annuity						
Asia Life Assurance	0.861	0.896	3.47	0.840	0.885	4.44
AIA	0.907	0.943	3.62	0.943	0.995	5.20
Aviva	0.943	0.982	3.98	0.930	0.981	5.14
GE Life I	0.910	0.947	3.71	0.893	0.941	4.78
GE Life II	0.846	0.879	3.34	0.818	0.860	4.22
OAC	0.907	0.945	3.74	0.908	0.957	4.98
Prudential Assurance	0.879	0.915	3.62	0.833	0.876	4.37
Participating Annuity						
HSBC Insurance	0.933	0.969	3.59	0.969	1.021	5.20
NTUC Income Co-op	1.006	1.047	4.09	1.024	1.081	5.61
Mean	**0.910**	**0.947**	**3.69**	**0.906**	**0.955**	**4.88**

Source: Author's computations, see text.
Notes: Money's worth ratios are in decimals and adverse selection costs are in percentage points. Computations pertain to a CPF participant who purchases the MS Scheme annuity at entry age 55 for a premium of S$99,600 and starts receiving payouts at age 62. The term structure of interest rate uses derived spot rates for 1, 2, 5, 7, 10 and 20-year bonds with linear interpolation between years.

Table 3
Robustness Analysis for Nominal Life Annuities Offered by Private Insurers under the CPF Plan (2007)

Panel A: Sensitivity to Alternative Mortality Assumptions

	Male			Female		
Mortality rates	**Annuitant**	**Population**	**AS**	**Annuitant**	**Population**	**AS**
2 years lighter	0.962	0.901	6.05	0.972	0.901	7.11
Base case	0.939		3.80	0.951		5.03
2 years heavier	0.917		1.57	0.929		2.86

Notes: This analysis uses the average annuity payouts (with bonus) of the private annuities given in Table 1. For the base case of 3.44%, the MWR values of this pseudo average-payout annuity are slightly lower than the mean of the individual MWR values reported in Table 2 because the individual computations incorporate interest accrued during the deferral period where applicable.

Panel B: Sensitivity to Alternative Long-Term Interest Rate Assumptions (±0.5% and ±1%)

Long-term interest rate	**Male**			**Female**		
	Annuitant	**Population**	**AS**	**Annuitant**	**Population**	**AS**
2.44%	1.067	1.010	5.70	1.110	1.033	7.69
2.94%	0.998	0.951	4.66	1.024	0.961	6.22
3.44% (base)	0.939	0.901	3.80	0.951	0.901	5.03
3.94%	0.889	0.858	3.10	0.889	0.849	4.07
4.44%	0.846	0.821	2.51	0.837	0.804	3.28

Source: Authors' computations.

Table 4
Illustrative Payouts and Money's Worth Ratios of CPF LIFE Plans (for a premium of S$67,000; various dates)

LIFE plans	Male			Female		
	Monthly payout (S$)	**Annuity component**	**MWR**	**Monthly payout** (S$)	**Annuity component**	**MWR**
Proposed LIFE plans *(as at February '08)*						
Refund 90	560	6%	1.306	540	8%	1.350
Refund 85	590	13%	1.315	560	16%	1.361
Refund 80	**610**	**24%**	**1.331**	**570**	**28%**	**1.371**
Refund 75	630	41%	1.341	580	45%	1.374
Refund 70	640	66%	1.323	590	68%	1.370
Refund 65	650	100%	1.284	590	100%	1.311
LIFE plans *(as at June '09)*						
LIFE Basic	519	6%*	1.264	496	8%*	1.308
LIFE Balanced	**556**	**24%***	**1.313**	**515**	**28%***	**1.355**
LIFE Plus	590	100%	1.308	531	100%	1.332
LIFE Income	632	100%	1.287	549	100%	1.313
LIFE plans *(as at September '09)*						
LIFE Basic	524	8.6%	1.240 [1.099]	500	13%	1.255 [1.088]
LIFE Balanced	**561**	**30%**	**1.252 [1.110]**	**520**	**35.5%**	**1.270 [1.098]**
LIFE Plus	594	100%	1.315 [1.149]	535	100%	1.340 [1.142]
LIFE Income	636	100%	1.294 [1.119]	553	100%	1.322 [1.118]

Source: Authors' computations; see text. Payout data obtained from CPF website (CPF 2008 and CPF 2009*e*).
Notes: The default plan offered at each point in time is bolded. Computations pertain to a CPF participant who joins the LIFE plan at age 55 for a premium of S$67,000, and starts receiving payouts at age 65. In particular, the parameter inputs generating this set of illustrative payouts in the CPF web calculator assume the Singaporean worker was born June 1958 (so he is age 55 in 2013); AV="More than S$11,000"; AI="More than S$54,000". The premium paid is split into a term component and an annuity component. The term component funds payouts from age 65 to the vesting age; vesting age differs across plans. The annuity component, expressed as a percentage of the annuity premium, funds payouts from the vesting age to death. The reported payouts are indicative only; actual payout will depend on actual CPF interest rates and mortality experience. CPF interest is computed monthly, reviewed quarterly and, compounded and credited annually. Figures marked with (*) are estimated. Money's worth ratios are computed using the riskless term structure of interest rate with long-term interest rate assumption of 3.44% and assume constant payouts over the participant's lifetime. The assumed CPF interest rate is 4% with the statutory additional 1% paid on the first S$60,000. The guaranteed amount refunded to the beneficiary upon the annuitant's death is the unused amounts left in the annuitant's CPF retirement account (term component plus any interest earned) and the unused amount of the annuity component (if refundable). MWR in brackets [ ] are based on an alternative long-term interest rate assumption of 4.44%.

Table 5
International Comparison of Money's Worth Ratios

Country	Study	Valuation Date	MWR (65-year old male; annuitant mortality)	Cost of Adverse Selection as % of Total Loading
US	Friedman and Warshawsky (1988)	1983	0.868	35.0%
US	Mitchell et al (1999)	1995	0.916	54.3%
UK [a]	Finkelstein and Poterba (2002)	1998	0.988	91.1%
		1998	0.962	62.0%
Singapore	Fong (2002)	2000	0.933	13.0%
Singapore	Doyle et al (2004)	2000	0.947	4.7%
Australia	Doyle et al (2004)	2000	0.939	49.7%
Singapore [b]	This study	2007	0.947	41.1%
		2008 - 2009	1.10 - 1.15	-

Source: Authors.
Notes: All the MWR values reported for Singapore are based on a 55-year old male instead of a 65-year old male. Total loading is defined as one minus money's worth of annuity for an individual from the general population.
[a] Results are reported in separate rows for the U.K. voluntary, and compulsory, annuity markets respectively. Data in both markets are drawn from annuities offered by commercial insurers.
[b] Results are reported in separate rows for annuities offered by commercial insurers, and new annuities offered by the CPF Board, respectively. MWR values for the latter are based on September 2009 LIFE plan payouts and a long-term interest rate assumption of 4.44%.